LOYOLA COLLEGE (AUTONOMOUS) CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **PHYSICS**

FIFTH SEMESTER – **NOVEMBER 2024**

UPH 5501 – QUANTUM MECHANICS

Date: 07-11-2024 Dept. No. Max. : 100 Marks

Time: 09:00 am-12:00 pm

	SECTION A - K1 (CO1)	
	Answer ALL the Questions	**(10 x 1 = 10)**
1.	**Definitions**	
a)	Matter waves	
b)	Dirac notation	
c)	Free particle	
d)	Spherical harmonics	
e)	Rigid rotator	
2.	**Match the following**	
a)	Black body radiation	- Super position principle
b)	Group velocity	- Erenfest theorm
c)	Spin angular momentum	- Bohr concept
d)	Electrons and their energy levels	- Planck's law
e)	Classical and Quantum analogue	- Stern-garlic experiment
	SECTION A - K2 (CO1)	
	Answer ALL the Questions	**(10 x 1 = 10)**
3.	**Fill in the blanks**	
a)	The change in wavelength in compton effect is _____ of the frequency of the incident radiation.	
b)	Hamiltonian operator is a _____ operator.	
c)	Ground state energy of the harmonic oscillator is also called _____.	
d)	Orbital angular momentum of an electron describes the _____ motion of an electron around the nucleus of an atom.	
e)	Hamiltonian for a particle moving in _____ potential energy has only kinetic energy which is expressed in terms of momentum.	
4.	**True or False**	
a)	Nuclear force depends on charge	
b)	Probability of finding a wave packet in a given region of phase space is called normalised wave function	
c)	[Lx. Ly] = i $\hbar$ Lz	
d)	Pauli's spin matrices are unit matrices.	
e)	Harmonic oscillator is an example for central potential.	
	SECTION B - K3 (CO2)	
Answer any TWO of the following in 100 words each.		**(2 x 10 = 20)**
5.	Explain Davidson and Germer experiment with a suitable diagram and also discuss how it	

	demonstrates the wave nature of electrons

6.	Discuss about the fundamental postulates of quantum mechanics. Provide a necessary explanation of each postulate. Mention its importance in quantum mechanics.
7.	Distinguish between group velocity and phase velocity show that group velocity is same as particle velocity
8.	Prove that (i) $[\sigma_x \sigma_y] = 2i\sigma_z$ $(ii)[\sigma^2 \sigma_x] = 0$
SECTION C – K4 (CO3)	
Answer any TWO of the following in 100 words each.	**(2 x 10 = 20)**
9.	Derive Schrödinger's time-independent wave equation.
10.	State Heisenberg uncertainty principle. Using it obtain the expression for ground state energy of hydrogen atom.
11.	Derive the energy Eigen value and Eigen function for a particle confined in a one-dimensional infinite potential well.
12.	Explain electron spin hypothesis using Stern Gerlach experiment with a suitable diagram.
SECTION D – K5 (CO4)	
Answer any ONE of the following in 250 words	**(1 x 20 = 20)**
13.	State and prove Ehrenfest's Theorems I and II which relates the laws of classical mechanics with quantum mechanics.
14.	Derive the energy eigenvalues and Eigen functions for a linear harmonic oscillator using series method.
SECTION E – K6 (CO5)	
Answer any ONE of the following in 250 words	**(1 x 20 = 20)**
15.	What is Compton effect and Compton shift? How do you relate the frequency of the scattered proton in terms of angle of scattering?
16.	Formulate Schrodinger equation for a rigid rotator with free axis. Obtain the Eigen function of a rotator for azimuthal component. Using this obtain the rotation energy Eigen value of a rigid rotator in a fixed plane.

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